KINEMATIC ANALYSIS AND TRUNK MUSCLE ACTIVATIONOFOPEN STANCE AND SQUARE STANCE INTENNIS BACKHAND DRIVE

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TABLE OF CONTENTS

I. INTRODUCTION

a) Statement of the problem
b) Objectives of the study
c) Delimitations
d) Hypothesis
e) Definition and explanation of terms
f) Significance of the Study

II.REVIEW OF RELATED LITERATURE

III.METHODOLOGY

a) Selection of Subjects
b) Selection of variables
c) Criterion measures
d) Collection of data
e) Statistical technique

IV.BIBLIOGRAPHY

CHAPTER I

INTRODUCTION

Biomechanics is an applied form of mechanics and consequently, the method used to investigate, it must be derived from those of mechanics. However, biomechanics have not developed in the wake of mechanics but as a bordering science in other scientific disciplines such as anatomy, physiology, and technique of sports (Gerhard Hochmuth, 1984).

Biomechanical or movement analysis is often thought of as just that- the process of observing (measuring) the performance of a skill, identifying faults in the performance, and providing feedback to the performer to help correct those faults. Indeed, these steps are part of a biomechanical analysis (Peter Merton McGinnis,2005).

People who are working in this field should have a basic knowledge about how a body moves, what are the major groups of muscles, and joints and in what proportion and degree they are to be used to get an optimum output. This approximately can provide an understanding of the nature of any skill, its economical way of execution, and its dependent factors, which in turn can build a larger scheme of economic movement. (Ralph L. Wickstrom,1977).

Knowledge of basic biomechanical concepts is also essential for the competent physical education teacher, physical therapist, physician, coach, personal trainer, or exercise instructor(Susan J. Hall,2003).

Analysis involves breaking something into smaller parts and then examining those parts. Biomechanics research at the practical, fundamental and theoretical levels has increased markedly in recent years. As this work becomes more complex and sophisticated, it is necessary for researchers to improve their instrumentation systems, experimental procedures, data recording, analysis methods and means of disseminating their findings. The ultimate success of biomechanics research in sport will depend greatly upon the creativity and competence of the researchers in their continual efforts to strive for more effective means of investigating human movement.

There are basically two methods by which motor skills can be analyzed the qualitative method and the quantitative method. With the qualitative method, the performance is evaluated subjectively. With the quantitative method, the performance is first recorded using photography, cinematography, electromyography, or some other recording technique and is then evaluated objectively on the basis of measurements taken from the records(James G. Hay and J. Gavin Reid,1988)

Analysis in both quantitative and qualitative contexts means identification of the factors that affect human movement performance, which is then interpreted using other higher levels of thinking (synthesis, evaluation) in applying the information to the movement of interest. Solving problems in human movement involves high levels of critical thinking and an interdisciplinary approach, integrating the many kinesiology sciences(Duane Knudson,2007).

Videography is the process of capturing images on a videotape or directly to a computer, also used to include the later analysis of these images(Roger Berlet,1954).

Electromyography is the technique of recording the electrical activity of motor unit firing. Not muscle force per se, but the electrical signal sent by the motor nerves to muscle fibers to create force. The electromyogram is the trace of the electrical signal detected by the electrode. Uses electrodes applied on the skin (surface) or implanted into the muscle (indwelling) as "antennas" to pick up voltage signals. Similar to ECG (EKG) – ECG is in fact electromyography of the heart muscle.

The EMG signal (as perceived from surface electrodes) is composed of many individual motor unit action potentials (MUAPs). Each MUAP has its own unique firing profile. Muscular efforts usually require the activation of more than 1 motor unit.According to Henneman's size principle, to increase strength; you recruit increasingly large, rapidly firing motor units. The result is a curve summation that can be difficult to analyze and interpret.

Tennis is a game played by people of all ages and of all skill levels. Courts are filling with more and more players as individuals come to realize the value of Tennis as a leisure-time activity, the relationship of physical exercise to health, and the satisfaction of participation. In addition, Tennis is becoming a year-round activity as indoor courts are developed to supplement the traditional outdoor arrangement(Wayne Pearce, Janice Pearce,1971).

Success in Tennis is greatly affected by the technique a player uses and biomechanics plays an integral role in stroke production. All strokes have a fundamental mechanical structure, and sports injuries primarily have a mechanical cause. Player's development based on scientific evidence allows an individualized approach to be structured, with due consideration to the key mechanical features of each skill, while also fostering flair and permitting the physical characteristics of a player to be considered. An understanding of biomechanics from a perspective is also important if player development is to occur with minimal risk of injury. By obtaining an understanding of the biomechanics involved in each Tennis stroke, coaches are able to direct athletes to use their muscles in the most efficient and injury-free ways(B.Elliot,2006).

Tennis is a unique game and most tennis players have different-looking tennis strokes. No one player hits their tennis forehand or backhand the exact same way nor should they aim to; however, when looking at the tennis technique of top professional players closer through slow motion video, some interesting discoveries about tennis technique canbe observed.

There are similarities in fundamental components in tennis technique which are shared by professional players - and these elements are usually not present in players at the recreational, club tennis and sometimes junior levels.

One of the elements that all high-level tennis players, college tennis players and

world-class tennis professionals share is efficient and biomechanical sound tennis strokes. In each of these groups, the high-level players share commonalities and distinct fundamentals of tennis technique. Although each player should have their own hitting and playing style, they all have basic technical elements in place that separate them from lower-level players.

The drive, on both wings, is the most important single stroke in tennis. It is played probably twice as often as all the other strokes combined. It is the key to all back-court games, and since a player must make at least one ground stroke before he can volley, the groundstrokes will always be more important than the net game. The drive is the only shot in tennis which is equally important in attack and defence. It can be used to win points outright by blasting speed or subtle placement, and can also be used to keep the ball going back when one is being attacked by an opponent. It is capable of a wider range of speed and angle than any other shot(Menu Syal,2004). an important role in hitting the tennis ball with accuracy and speed.

A backhand drive is defined as a drive that shows the back of the hand in front of the opponent when hitting the ball. For a right-handed player, this means that a ball is coming to the left of the body and vice versa for a left-handed player. But the emergence and popularity of the two-handed backhand has forced some rethinking of that definition. Because the position of the hands on the racket is very different for a two-handed backhand, the more straightforward explanation is that the backhand is a shot that approaches the right side of a left-hander and the left side of a right-hander. (Groppel&Roetert, 2001).

For more than a hundred years, the backhand will be hit primarily with only one hand gripping the racket. But in recent years, the number of two-handed backhand hitters appears to have outnumbered the one-handed backhand players. In the 1930s and 1940s, Australian Vivian McGrath will be sporting a two-handed backhand. Ironically, it was a two-handed forehand of Pancho Segura in the 1950s and 1960s that began to capture the attention of many players. His control of the ball will be nothing short of amazing and he held his own against the taller and stronger professional players. However, it was the success of Chris Evert in the 1970s and 1980s that created the two-handed backhand explosion. Segura primarily played before a few thousand spectators and Evert played before millions on international television. Once the women saw Evert holding a Wimbledon trophy, it almost closed the door on future one-handed female backhand hitters. On the men’s side, it will be Bjorn Borg and Jimmy Connors who set the pace for two-handed male players. The saga that a double-handed male backhand player couldn't win on the Wimbledon grass courts will be dismissed by Borg, who won the coveted prize five times. None other than Pete Sampras has stated that the Russian phenom Marat Safin will be the two-handed backhand hitter to watch as the dominant player in the early years of the let 21st century. Sampras may be right, as he lost the United States Open finals in September 2000 to Safin in three straight sets. (Roetert&Groppel, 2001).

The two-handed backhand drive of tennis has changed a lot in the past ten years. Player nowadays rarely uses the traditional two-handed backhand. Rather, the modern

topspin two-handed backhand drives uses by most of the top beginners and advanced players. The change in racket design has been responsible for the evolution ofthe two-handed backhand technique. The players can strike the ball with additional power and control, because of the rackets are larger, lighter, and tighter than conventional wooden rackets. These evolutions in the two-handed backhand technique have affected the footwork, type of grip, and racket forward and backswing swing of present tennis players.

Grips

There are two types of grips most commonly associated with the one-and two-handed backhands: the eastern and the continental. The eastern grip on the one-handed backhand places the palm of the hitting hand on top of the grip at approximately a 45-degree angle to the racket handle. This requires an eastern-grip forehand hitter to change grips when switching from a forehand to a backhand, and vice versa. The continental grip normally used for both forehand and backhand ground Strokes and volleys, thus requiring no grip changes in the heat of the battle. Many argue that there is insufficient time to change grips. Studies have shown, however, that a player can learn to switch grips faster than he can move his feet a single step. The hands are simply faster than the feet. There were some situations in which players had difficulty performing two separate tasks (stepping while changing grips) simultaneously Each person would be wise to experiment with both grips and note the position of the wrist to achieve a vertical racket when impacting the ball. The advantage of the continental grip is that it places the racket face in a ready position for an underspin backhand, but it forces the wrist into a vulnerable position to strike the ball with topspin. In today's professional tennis, the underspin backhand shot is used far less than a flat or topspin shot. For intermediate and senior tennis, the underspin shot is used more often. (Roetert&Groppel, World Class Tennis Technique, 2001).

Footwork

Tennis players are interested to know the position of the body during the racket swing as when hitting with an open stance and close stance. The players playing with a single-handed backhand mainly use a closed stance. In a closed stance non-dominating foot begins to push the player's dominating foot to step forward diagonally. In the open stance upper body uncoils from the coiled position, while both the feet rotate at their position and the toes point towards the net. When the player's navel is facing the net before starting the body coil on the backward swig it is also called the open stance. (Groppel&Roetert, 2001)

In all cases, the right footwork permits a player to uncoil his body from the coiled position appropriately by accomplishing a balanced position.

Two-handed backhand drive

The two-handed backhand drive comes under one of the most difficult shots of tennis. The backhand drive consists of many phases in the shot which make it one of the hardest strokes to learn, but it's necessary to gain mastery over the two-handed backhand drive nowadays in tennis. Earlier tennis was a game of less fitness butnowadays it developed into a power game.

At present, having an excellent two-handed backhand drive means being able to play the ball hard with topspin.

The basic double-handed backhand is one of the "bread and butter shots" of the game, in particular, the mainstay of a rally played from the back of the court. It can be a safe shot, played calmly and without undue pressure, testing the opponent's capabilities. It can also be a forcing shot aimed at wearing down the opponent's resistance. This is played both down the line and cross-court with equal ease. (Hume, 1986)

STATEMENT OF THE PROBLEM

"Kinematic analysis and Trunk muscle activation of open stance and square stance in Tennis backhand drive**.**"

OBJECTIVES OF THE STUDY

1. To find out the differences between square stance and open stance in tennis backhand drive.
2. To find out the muscle activation pattern during open stance and square stance in tennis backhand drive.
3. To find out the major muscle responsible for the execution of open stance and square stance tennis backhand drive.
4. To study the effects of selected variables of open stance and square stance with the speed and accuracy of the ball after the contact.

DELIMITATIONS

Since the study will be conceptualized with a very specific purpose for selected subjects.

The research scholar confined this study to the following areas:

1. The study will be confined to university-level male Tennis players of L.N.I.P.E, Gwalior.
2. The study will be delimited to 10 players only.
3. The study will be delimited to the Right-Hand player's age ranging between 18-25 years.
4. The study will be delimited to down the line two-handed backhand only.
5. The study will be delimited to the following selected kinematic variables.

A. Linear kinematic variables

a) Height of centre of gravity at the moment of contact.
b) Speed of the ball after the contact.

B. Angular kinematic variables

a) Angle at right and left shoulder joint
b) Angle at right and left elbow joint
c) Angle at right and left knee joint
d) Angle at right and left hip joint

C.The study will further be delimited to the following electromyographical parameters during the execution phase:

a) Average rectified EMG for the contraction
b) Time taken from muscle activation to execute backhand drive
c) Contraction duration

D. The study will further be delimited to the following muscles:

a) Rectus abdominis
b) External oblique
c) Erector spinae

HYPOTHESIS

On the basis ofthe research cited, book depiction, scientific facts available and the research scholar's own understanding of this research study following hypotheses were formulated:
It will be hypothesized that-

1. There may be a significant difference between muscle activation in square stance and open stance in Tennis backhand drive.

2. There may be a significant relationship between selected muscle activation and kinematic variables of square stance with the speed of the ball after the contact.

3. There may be a significant relationship between selected muscle activation kinematic variables of open stance with the speed of the ball after the contact.

DEFINITION AND EXPLANATION OF TERMS

Biomechanics

Biomechanics is the science concerned with the internal and external forces acting on the human body and the effects produced by these forces (Hay, 1985).

Biomechanics is the application of mechanical principles in the study of living organism (Hall, 1991).

Kinematics

Kinematics is that branch of biomechanics that is concerned with describing the motion of the bodies. It deals with such things as how far a body moves, how fast it moves and how consistently it moves (Hay, 1985).

Kinematics is the study of the description of the motion, including consideration of space and time (Hall, 1991).

Centre of the Gravity

The point at which the body's mass seems to be concentrated. The balance points of the body. Centre of the gravity is the point around which the mass and weight of the body are balanced in all directions (Hall, 1991).

Tennis

Tennis is a sport that can be played individually against a single opponent (singles) or between two teams of two players each (doubles). Each player uses a racquet that is strung with a cord to strike a hollow rubber ball covered with felt over or around a net and into the opponent's court. The objective of the game is to play the ball in such a way that the opponent is not able to play a good return.

Double handed backhand

For tennis players backhand drive starts from the non-dominant side of their body, the racket moves forward as contact is made with the ball then it move across the body, and it ends on the dominance side of player's body. It is played with one hand or with double hand and it is considered to be difficult to master as compared to the forehand.

Open Stance

Most of the players prefer to hit a ball with an open stance in today's era. To perform it correctly, a player must coil his/her upper body with the backswing and pivoting his/her toes on the spot with the forward swing of the racket keeping towards the net. The coil made by the player generates torque that will help the player produce extra power to the stroke. That energy and power will pass to the ball through racket at the time of impact to the ball.

Square stance

While performing square stance, the players leading foot should be placed diagonally to the net. When the player standing at the baseline near the centre mark, the player have to place his leading foot(for right handed player left side of the body and vice versa for left hander player) slightly forward to play the ball. After contact, return to ready position and be prepared for the next ball. The square is very useful for baseline players. Stance is "square to the line of play", in square stance the players feet should be pointing in the direction you are oncoming ball.

EMG

Electromyography is the technique of recording the electrical activity of motor unit firing. Not muscle force per se, but the electrical signal sent by the motor nerves to muscle fibres to create force

SIGNIFICANCE OF THE STUDY

The modern age of sports is the excellences in every perfection and purification of skill has got its immense importance and research in the field has added allow in excelling the performances of the present study may be contributing to the following:

1. The findings of the present study may be determined as contributing factors to the performance of backhand drive in Tennis.
2. This study may be helpful to the physical education teachers, coaches and tennis players to evaluate the backhand drive in Tennis.
3. The findings of the study may also help coaches to work on the particular group of musclesthat will help in backhand drive in Tennis.
4. The results of the study may help the tennis players and coaches in a general understanding of the major muscle group which affects the square stance and close stance backhand drive in Tennis.
5. The results of the study may help the tennis players and coaches to understand the biomechanical aspects of backhand drive in Tennis.

CHAPTER II

REVIEW OF RELATED LITERATURE

(Knudson & Blackwell, 2000),Electromyography of the trunk muscles were comparedbetween the open and square stance forehand drives of 14 collegiatetennis players. Surface EMG were bilaterally collectedfrom the rectus abdominis (RA), external oblique (EO), and erectorspinae (ES) in open and square stance forehand drives. EMGdata were transferred by telemetry, 12 bit A/D converted at1000 Hz, and stored for analysis. Rectified and smoothed EMGdata were normalized (NEMG) to maximal isometric voluntarycontractions and mean NEMG were calculated during the forwardswing and followthrough phases of the stroke. A2 × 2 × 2 × 6 factorial ANOVA (Gender, Stance, Phase, Muscle) with repeated measures on Subject showed significant ($p < 0.05$) effects of Gender, Muscle, Phase, and several interactions. The nonsignificant differences in muscle activation between stances did not support the belief of tennis experts that open stance forehands require greater trunk activation than square stance forehands. Mean NEMG of the ES were significantly ($p < 0.05$) larger than EO or RA, which will be consistent with observations of tennis-specific strength imbalances and increasing incidence of low back injuries in tennis.

(**Rogowski et al., 2011)**,This study compared EMG activity of young tennis players' muscles during forehand drives in two groups, GD—those able to raise by more than 150% the vertical velocity of racket-face at impact from flat to topspin forehand drives, and GND, those not able to increase their vertical velocity to the same extent. Upper limb joint angles, racket-face velocities, and average EMGrms values, were studied. At similar joint angles, a fall in horizontal velocity and a rise in racket-face vertical velocity from flat to topspin forehand drives were observed. Shoulder muscle activity rose from flat to topspin forehand drives in GND, but not for drives in GD. Forearm muscle activity reduced from flat to topspin forehand drives in GD, but muscle activation will be similar in GND. The results show that radial deviation increased racket-face vertical velocity more at impact from the flat to topspin forehand drives than shoulder abduction.

(Busuttil et al., 2020),The purpose of this study was to compare double-handed backhand kinematics of the non-dominant wrist of tennis players using either an eastern or continental grip position with the non-dominant hand. Trajectory data were captured using sixty reflective markers on sixteen sub-elite right-handed tennis players using a 12-camera VICON motion capture system (250 Hz). Participants executed double-handed backhands using two non-dominant grip positions (Eastern [E] and Continental [C]), aiming for two crosscourt zones (Deep [D] and Short [S]), totalling to four conditions (ED, CD, ES and CS). Three successful attempts from each condition were selected for analysis. The eastern grip demonstrated faster horizontal racket head velocity compared to the continental grip. However, no differences were observed in accuracy or spin rate between grips ($p > 0.05$). In the non-dominant upper limb, elbow flexion was smaller in the continental condition throughout the swing, whilst wrist extension and ulnar deviation was larger. Collectively,

these data suggest that the continental grip may place the wrist in a position vulnerable to overuse injury. Future research into the kinetics of the double-handed backhand would help better understand the onset of ulnar-side wrist pain in tennis.

(Muhamad et al., 2011),The study examines and compares the effectiveness of single and double handed backhand strokes in terms of accuracy and percentage of success, and also to determine whether there is an association between their agility level and the of choice of strokes used. Samples were tested for agility and a two-item skill test for accuracy and percentage of success. Results show that double handed backhand have better accuracy and percentage of success but the difference was not significant. It was found that agility did not have any influence on the choice of backhand strokes.

(Wang et al., 2010),The purpose of this study was to investigate the differences of momentum transfer from the trunk and upper extremities to the racket between open and square stances for different skill levels players in the two-handed backhand stroke. The motion capture system with twenty-one reflective markers attached on anatomic landmarks of the subject was used for two-handed backhand stroke motion data collection. Twelve subjects were divided into an advanced group and an intermediate group based on skill level. The three-dimensional linear and angular momentums of the trunk, upper arm, forearm, hand and racket were used for kinetic chain analysis. Results showed that all players with the square stance had significantly larger backward linear momentum contribution in trunk and upper arm than with the open stance ($p<.05$) irrespective of playing level. However, the external rotation angular momentum of the shoulder joint was significantly larger with an open stance than with a square stance ($p=.047$). Comparison of playing levels showed that the intermediate group performed higher linear momentum in three components of the trunk, upper arm backward linear momentum, and trunk right bending angular momentum than the advanced group significantly ($p<.05$). The advanced group reduces trunk linear movement to keep stability and applies trunk and linkage segment rotation to generate backhand stroke power. The advanced group also has a quick backswing for increasing acceleration and maintains longer in the follow-through phase for shock energy absorption. This information could improve training protocol design for teaching the two-handed backhand stroke and teaching players, especially beginners, how to make an effective stroke.

(Koronas &Koutlianos, 2021),Tennis is one of the most popular individual sports all over the world. Strength and trained muscles are required for a player in order to achieve a good backhand, forehand, volley or flat stroke. Especially while playing tennis are many kinds of muscles involved, including the lower body muscles, trunk muscles and upper body muscles. The purpose of this review is to present the activated muscles in the basic tennis movements of forehand and backhand and to improve the knowledge about their role in order to help tennis players and coaches to enhance their tennis performance and to reduce risk of injury. To support the present review, data were gathered from library and network databases using keywords such as tennis, muscles, forehand, and backhand for publications between 2015 and 2019. Overall, thirty-five references were detected and used. The literature showed that forehand and backhand drives are strokes that involve muscles not only of the upper limbs but also a series of more complex movements that start with the feet and end with the

swinging of the tennis racket. The insight for the action of the muscles in tennis should be utilized in tennis players so as to better understand the muscular function which takes part in specific tennis movements and has a greater performance. In addition, this knowledge is considered strongly beneficial for the coaches and the favourable building of the training process.

(Giangarra et al., 1993),It is generally believed that tennis players using a double-handed backhand rarely develop lateral epicondylitis since the helping arm appears to absorb more energy and changes the mechanics of the swing. The purpose of this paper will be to compare muscle activity about the elbow in single- and double-handed backhand strokes in competitive tennis players. Muscle activity in 3 elbow extensors, a wrist flexor, and a forearm pronator of the dominant arm will be compared during the single-handed (N = 14) and double-handed (N = 13) backhand ground strokes using indwelling electro myography and high-speed cinematography. Significantly higher activity will be seen in the double-handed technique in the flexor carpi radialis muscle in the preparation phase and in the pronator teres muscle in the acceleration phase. Higher flexor carpi radialis muscle activity in preparation of the double-handed stroke appeared to be a function of the double-handed grip used on the racquet, and the increased pronator teres muscle activity in acceleration indicated maintenance of greater pronation provided by the grip of the non- dominant hand. The decreased occurrence of lateral epicondylitis in players using a double-handed back hand may not be caused by decreased extensor activity, but rather by factors associated with flawed stroke mechanics more often seen in the single-handed technique.

(Rota et al., 2014),The study examined the fatigue effect on tennis performance and upper limb muscle activity. Ten players were tested before and after a strenuous tennis exercise. Velocity and accuracy of serve and forehand drives, as well as corresponding surface electromyographic (EMG) activity of eight upper limb muscles were measured. EMG and force were also evaluated during isometric maximal voluntary contractions (IMVC). Significant decreases were observed after exercise in serve accuracy (−11.7%) and velocity (−4.5%), forehand accuracy (−25.6%) and consistency (−15.6%), as well as pectoralis major (PM) and flexor carpi radialis (FCR) IMVC strength (−13.0% and −8.2%, respectively). EMG amplitude decreased for PM and FCR in serve, forehand and IMVC, and for extensor carpi radialis in forehand. No modification will be observed in EMG activation timing during strokes or in EMG frequency content during IMVC. Several hypotheses can be put forward to explain these results. First, muscle fatigue may induce a reduction in activation level of PM and forearm muscles, which could decrease performance. Second, conscious or subconscious strategies could lead to a redistribution of muscle activity to non-fatigued muscles in order to protect the organism and/or limit performance losses. Otherwise, the modifications of EMG activity could also illustrate the strategies adopted to manage the speed-accuracy trade-off in such a complex task.

(Ryu et al., 1988), Shoulder injuries in tennis players are common because of the repetitive, high-magnitude forces generated around the shoulder during the various tennis strokes. An understanding of the complex sequences of muscle activity in this area may help reduce injury, enhance performance, and assist the rapid rehabilitation of the injured athlete., The supraspinatus, infraspinatus, subscapularis, middle deltoid, pectoralis major, latissimus dorsi, biceps brachii, and serratus anterior muscles were studied in six uninjured male Division II collegiate tennis players using dynamic electromyography (EMG) and synchronized high-speed photography. Each subject performed the tennis serve and the forehand and backhand groundstrokes, and each stroke will be divided into stages., The tennis serve contains four stages. Three stages characterize the forehand and backhand ground strokes. Our results indicate that the subscapularis, pectoralis major, and serratus anterior display the greatest activity during the serve and forehand. The middle deltoid, supraspinatus, and infraspinatus are most active in the acceleration and follow-through stages of the backhand. The biceps brachii increases its activity during cocking and follow-through in the serve with a similar pattern noted in the acceleration and follow-through stages of the forehand and back hand. The serratus anterior demonstrates intense activity in the serve and forehand, thus providing a stable platform for the humeral head and assisting in glenohumeral-scapulothoracic synchrony., The tennis serve and forehand and backhand ground strokes are accomplished by complex sequences of muscle activity that incorporate contributions from the lower extremities and trunk into smooth, coordinated patterns. Although our study focused on shoulder function in the uninjured tennis player, it may provide a basis for understanding abnormal shoulder biomechanics that contribute to pain and dysfunction. The serratus anterior deserves special emphasis, for our study showed that its activity is essential to each of the three tennis strokes. Because of the similarities between the tennis serve and overhead throw, a conditioning program comparable to one pitchers use many be appropriate for tennis players.

(Alizadehkhaiyat& Frostick, 2015),There is no consensus about the main aetiology of Lateral Epicondylitis (LE) or Tennis Elbow. While electromyographic assessment of alterations in neuromuscular control and activation patterns of forearm muscles has received increasing interest as potential intrinsic factors in non-tennis players, there has been insufficient attention in tennis players. The purpose of present review will be to search the literature for the electromyographic studies of forearm muscles in tennis players in order to (1) identify related implications for LE, (2) highlight key technical and methodological shortcomings, and (3) suggest potential pathways for future research. An electronic search of PubMed, Scopus, Web of Science, and Google Scholars (1980 to October 2014) will be conducted. Titles, abstracts, and full-text articles were screened to identify “peer-reviewed” studies specifically looking into “electromyographic assessment of forearm muscles” in “tennis players”. After screening 104 articles, 13 original articles were considered in the main review involving a total of 216 participants (78% male, 22% female). There were indications of increased wrist extensor activity in all tennis strokes and less experienced single-handed players, however with insufficient evidence to support their relationship with the development of LE. Studies varied widely in study population, sample size, gender, level of tennis skills, electrode type, forearm muscles studied, EMG recording protocol, EMG

normalisation method, and reported parameters. As a result, it will be not possible to present combined results of existing studies and draw concrete conclusions in terms of clinical implications of findings. There is a need for establishment of specific guidelines and recommendations for EMG assessment of forearm musculature particularly in terms of electrode and muscle selection. Further studies of both healthy controls and tennis players suffering from LE with adequate sample sizes and well-defined demographics are warranted.

CHAPTER III

METHODOLOGY

This chapter describes the methodology and procedure of the study. It includes the selection of subjects, variables, collection of data and statistical techniques to be employed for the analysis of data.

SELECTION OF SUBJECTS

For the study, 15 male, university-level tennis players will be selected purposively from Lakshmibai National Institute of Physical Education. Therefore, it is considered that subjects possessa reasonable level of technique of backhand drive.

SELECTION OF VARIABLES

From the researcher's understanding of the problem and based on discussion with experts, gleaned through the literature,For the muscle activation and Electromyographical comparison of open and square stance backhand drive, the followingvariables will be selected:

A. Linear kinematics variables in square stance.

- Height of centre of gravity at the moment of contact.
- Speed of the ball after the contact.

B. Linear kinematics variables in open stance.

- Height of centre of gravity at moment of contact.
- Speed of the ball after the contact.

C. Angular kinematic variables selected for the purpose of the study at moment of contact in square stance are:

- Angle at right and left shoulder joint
- Angle at right and left elbow joint
- Angle at right and left knee joint
- Angle at right and left hip joint

D. Angular kinematic variables selected for the purpose of the study at moment of contact in open stance are:

- Angle at right and left shoulder joint
- Angle at right and left elbow joint
- Angle at right and left knee joint
- Angle at right and left hip joint.

E. The study will be confined to the activity in the following muscles:

- Rectus abdominis
- External oblique
- Erector spinae

CRITERION MEASURE

1. The performance of each subject's double-handed backhand stroke will be taken as a criterion measure for the current study. The performance will be recorded based on the execution of skills; this will be assessed by the Hewitt test. The validity of the test is 0.625 to 0.93 and the reliability of the test is 0.94.
2. All the angles at the joints were measured in degrees.
3. The speed of the ball will be measured in km/hr.
4. Contraction duration in seconds
5. Average Rectified EMG for contraction in microvolt.
6.Contraction duration in seconds.

COLLECTION OF DATA

The performance of the subjects during the execution of backhand drive by the subjects, filming protocol,and kinematic, and electromyographical comparison are described below:

For the collection of data, five male right tennisplayers will be selected purposely from Lakshmibai National Institute of Physical Education, Gwalior. Total observations and collection of the data will be done on the same day, to obtain a reliable measurement of the variables, a high speed digital camera and kinovea 2D motion analysis software will be used. The video graphs will be taken by a professional photographer and later on the video graphs will be analyzed using kinovea 2D motion analysis software by experts. For standardizing EMG assessment procedures bipolar electrodes of pre-gelled silver-silver chloride material will be used to record the activity and hence the data may be consideredas reliable.

MEASUREMENT OF THE PERFORMANCE OF THE SUBJECTS

The performance of the backhand drive of each subject will be measured by using Hewitt's Tennis Achievement test.Hewitt's tennis achievement test evaluates three basic skills in tennis at the university level--service, forehand, and backhand drives. By use of the "test-retest" method reliabilities range from .75 to .94. Validity coefficients for each of the three skills in tennis when compared with individuals' rank order of playability range from .52 to .93.

Achievement scale norms for the forehand, backhand, and service skills at the university level are listed for the beginner, intermediate, and varsity groups. EMG variables will be measured by the individual difference in the action potential of the selected muscles of the trunk during maximum voluntary contraction at the time of execution of the backhand drive. Ten trials will be given to each subject and the best one will be considered.

FILMING PROTOCOL AND ANALYSIS

The video will be taken by a professional photographer, who is considered to be an expert in this area. After loading the videos, the photos will be taken by pausing the video at the desired moment with the help of Kinovea software. Based on Videography obtained the scholar will develop the stick figures in which data about various kinematic variables will be taken. The stick figures will be developed by using the joint point method with help of Kinovea software.

RELIABILITY OF DATA

The reliability of data will be established by instrument reliability. The instrument which is used in this study will be taken from the research laboratory of LNIPE, Gwalior and hence their reliability isensured. All the measurements about the selected c variables will be taken by the research scholar under the expert's guidance, so the data collection for the present study will be considered to be reliable.

INSTRUMENTATION

For analyzing the muscle's activities, passive surface EMG will be used. Each subject's skin will be prepared for EMG electrode placement by shaving, abrading the skin, and then cleaning the area thoroughly with an alcohol swab.

STATISTICAL PROCEDURE

1. For the muscle activation and kinematic comparison of square stance and open stance of double-handed backhand drive in tennis paired sample t-test will be used.

2. Pearson's product-moment correlation will be used to determine the relationship between kinematic variables of square stance and open stance in tennis double-handed backhand drive with the speed of the ball.

3. All the Data will be analyzed with the help of SPSS version 26.

4. For testing the hypothesis the level of significance will be set at 0.05.

BIBLIOGRAPHY

1.BOOKS

- James G Hay,"The Biomechanics of Sports Techniques", Practice Hall (Englewood Cliffs, NewJersey), 1999.

- Susan J Hall, "Basic Biomechanics" 4th ed. (New York: McGraw Hill), 1995.

- Rathore, Dr. M. S., "TENNIS THE ULTIMATE GAME",(Khel Sahitya Kendra, New Delhi,2013).

- Evans, Richard, "The ATP Tour: Ten Years of Superstar Tennis", (St Martin's Press, London, United Kingdom 1999).

- Ammar, Ben "Traveling the Tennis Tour: The Men's Professional Tour", (Universal Publishers, USA, 2004)

- Ramesh Rai, "Mechanical Aspects of Human Motion",agrim publication, 2003.

2. JOURNALS AND ARTICLES

- Alizadehkhaiyat, O., & Frostick, S. P. (2015). Electromyographic assessment of forearm muscle function in tennis players with and without Lateral Epicondylitis. *Journal of Electromyography and Kinesiology*, *25*(6), 876–886. https://doi.org/10.1016/j.jelekin.2015.10.013

- Busuttil, N. A., Reid, M., Connolly, M., Dascombe, B. J., & Middleton, K. J. (2020). A kinematic analysis of the upper limb during the topspin double-handed backhand stroke in tennis. *Sports Biomechanics*, *0*(0), 1–19. https://doi.org/10.1080/14763141.2020.1726994

- Giangarra, C. E., Conroy, B., Jobe, F. W., Pink, M., & Perry, J. (1993). Electromyographic and cinematographic analysis of elbow function in tennis players

using single- and double-handed backhand strokes. *The American Journal of Sports Medicine*, *21*(3), 394–399. https://doi.org/10.1177/036354659302100312

- Knudson, D., & Blackwell, J. (2000). Trunk Muscle Activation in Open Stance and Square Stance Tennis Forehands. *International Journal of Sports Medicine*, *21*(5), 321–324. https://doi.org/10.1055/s-2000-3776
- Koronas, V., &Koutlianos, N. (2021). MUSCLE ACTIVATION DURING FOREHAND AND BACKHAND DRIVES IN THE SPORT DISCIPLINE OF TENNIS. *Facta Universitatis. Series: Physical Education and Sport*, *0*, 601–609. https://doi.org/10.22190/FUPES201130058K
- Muhamad, T. A., Rashid, A. A., Razak, M. R. A., &Salamuddin, N. (2011). A comparative study of backhand strokes in tennis among national tennis players in Malaysia. *Procedia - Social and Behavioral Sciences*, *15*, 3495–3499. https://doi.org/10.1016/j.sbspro.2011.04.324
- Rogowski, I., Rouffet, D., Lambalot, F., Brosseau, O., &Hautier, C. (2011). Trunk and Upper Limb Muscle Activation During Flat and Topspin Forehand Drives in Young Tennis Players. *Journal of Applied Biomechanics*, *27*(1), 15–21. https://doi.org/10.1123/jab.27.1.15
- Rota, S., Morel, B., Saboul, D., Rogowski, I., &Hautier, C. (2014). Influence of fatigue on upper limb muscle activity and performance in tennis. *Journal of Electromyography and Kinesiology*, *24*(1), 90–97. https://doi.org/10.1016/j.jelekin.2013.10.007
- Wang, L.-H., Lin, H.-T., Lo, K.-C., Hsieh, Y.-C., & Su, F.-C. (2010). Comparison of segmental linear and angular momentum transfers in two-handed backhand stroke stances for different skill level tennis players. *Journal of Science and Medicine in Sport*, *13*(4), 452–459. https://doi.org/10.1016/j.jsams.2009.06.002

3. MISCELLANEOUS

- https://scholar.google.com
- https://en.wikipedia.org
- https://www.sciencedirect.com